ERROR in ESP - Emission Performance Test

Caution to Improve - Operational Performance of ESP

Pollution Control Equipment like ESP, Bag Filter etc should give effective performance to control emission within the authority prescribed range.

ESP Design mainly depends on parameters like Inlet gas flow, Inlet dust concentration, Ash particle size, Ash chemical composition, Migration velocity, Electrical resistivity of fly ash & Specific Collection Area (SCA in $m^2/m^3/s$**).**

ESP's Performance test accuracy is most neglected activity in the plant & very less significant for end users. Any error in the testing is directly proportional to emission result & wrong performance data

According to my analysis & field experience, In most of the ESP's (>90%) Emission test result is not meeting the emission designed parameters consistently.

ESP performance test code for Iso-kinetic sampling method is IS-11255, EPA Method-5 (at Outlet of Chimney) & Method–17 (at Inlet of Chimney). Repeatability & Reproducibility are the key points for any Performance Test.

ESP performance improved by presence of SOx vapours, Moisture content, Sodium alkali salts, Ferrous salts, Silica salts. ESP performance deteriorate by presence of CaO, MgO, Chlorides & higher fouling tendency of electrodes.

CRITERIA TO ELIMINATE ERROR IN COMMISSIONING & TESTING

1. **GD test velocity** mapping to achieve uniform gas distribution, for best performance try to achieve >0.5 m/s to <0.9 m/s **OR** design / operating velocity
2. **Gas Tightness** / Leak test of ESP assembly & casing @ min +100 mmwc
3. **Air Load Test by running ID fans (Induced draught fans) with cold air.** ID fan in OFF condition is not preferable during air load test. Results form both method (ID fan OFF/ON) should be same, if conducted
4. **Separate Earthing** for ESP equipments like TRCC, MCC, Control Panel
5. **Separation of Cable Tray & Cables** for ESP's Electrical power, Instrument control & signal cables
6. **No Air Ingress** in ESP from Manhole, Door, Air lock Valve, Peep hole
7. **Rubber padding** (non-conductive surface) between VFD, TR panel, MCC panel base & platform

8. **Number of Sampling Port holes** & their sizes at ESP inlet & ESP outlet w.r.t. performance test code. Normally, The sampling ports shall be made in straight duct / stack length of 8D downstream and 2D upstream to avoid any flow disturbance / turbulences.
9. **Location & Elevation of Sampling Port** at ESP inlet & ESP outlet w.r.t. performance test code
10. **Flue gas temperature drop**≈10ºC max. & Pressure drop≈25 mmwc max. across ESP

CHECKS TO ELIMINATE ERROR IN EMISSION PERFORMANCE TESTING

A. BEFORE START PERFORMANCE TEST

1. **Review procedure for ESP performance** test method, SPM sampling & measurement method
2. Confirm the basis of time duration for total sampling & each traverse point, gas flow quantity required for sampling
3. Review calibration certificate for stack monitoring kit
4. Record sampling nozzle details like type, diameter, area
5. **Re-check Size, Number of sampling port holes**, Location & Elevation as per performance test code - IS 11255 / EPA code
6. Check details like type of Pitot tube & it's constant, fluid used in manometer (Water/Red-oil), Technique used to measure moisture content is flue gas
7. Check Flue gas velocity measurement procedure, used to calculate Flue gas flow rate
8. **No air or gas leak in sampling train** arrangement like vacuums pump, nozzle & thimble holder assembly, Attend before start
9. **Witness & Record the Thimble empty initial weight,** carryout thimble conditioning, do Thimble marking before start of test because

1. If Initial weight is not known, emission test result is uncontrolled

2. Thimble may be wet, scratched, punctured, change of thimble etc

10. **Method of Thimble conditioning** - Keep thimbles for 1 hour in Oven at 110ºC to ensure dryness because these thimbles easily absorbs moisture from the ambient/gas). After keeping thimbles in Oven for one hour keep the thimbles in Silica gel desiccator for 15 minutes, so as to cool the thimble without absorbing moisture)
11. Do not allow to change in ESP controller operational setting just before & after the SPM sampling measurement. Record controller's mode of operation & setting

B. DURING PERFORMANCE TEST

1. **Iso-kinetic sampling condition** i.e. when the velocity of the flue gas flowing through duct / stack is equal to the gas being sucked into the sampling train. Witness and adjust the pump suction (LPM) such that, the gas enters the sampling nozzle at the same velocity. In case, if the LPM is more, then excess of gas and dust will get sucked into the sampling thimble, and if the LPM is less, then less gas and dust will get sucked into the sampling thimble. Both these conditions are not isokinetic, hence would give wrong results of SPM - Emission
2. **Witness the sampling nozzle tip opening direction** inside the flue gas path (in Gas flow direction) for proper suction of gas at desired flow rate, if not placed as specified way emission test result will be uncontrolled
3. Adjust the correct Flue gas flow rate through the thimble (in LPM) to achieve Iso-kinetic sampling condition
4. **Keep a watch on air/gas leak in sampling train** arrangement like vacuums pump, nozzle & thimble holder assembly, during test
5. Witness & Record the Flue gas temperature, Ambient temperature, O_2% & CO_2% at ESP inlet & outlet, Gas flow rate & time during sampling
6. **Error / Malfunctioning in Gas flow rate** (Nm^3/hr) measured quantity shall change the entire outcome of emission test result
7. Insist for sampling of Inlet Dust & Outlet Dust loading simultaneously
8. Specific power consumption (kwh/Nm^3) of flue gas flow & dust loading

C. AFTER COMPLETION OF PERFORMANCE TEST

1. **Witness & Record the Thimble filled weight**, carryout thimble conditioning, check Thimble marking after completion of test because

1. If Final weight is not known, emission test result is uncontrolled

2. Malfunctioning / Weight reduction of Emission collected in thimble, loss of collected emission during thimble transfer, punctured, Improper removal of moisture, change of thimble, inaccuracy in final weight measurement of thimble etc

2. **Demand for site preliminary calculation report** from testing agency based on the recorded data after completion of emission testing and before leaving the site
3. **Recheck final Performance test report** w.r.t. earlier recorded data during test, for any malfunctioning or error in final result calculation
4. The dust concentration (suspended particulate matter-SPM) is amount of dust collected in Thimble per unit gas volume sampled
5. **SPM (gm/Nm3)= (**Final weight of thimble-**W2 -** Initial weight of thimble-**W1) / (**sampling rate **Qs x** time **t)**

MAJOR POINTS TO IMPROVE ESP'S PERFORMANCE

1. Baffles adjustment to correct minor unbalanced Flue gas flow distribution in the ESP fields
2. GD Screen (Gas Distribution Screens) replacement
3. Stroke length of the Rapping mechanism for high intensity & Rapper timer setting
4. Replacement of Single phase TR set by Three phase TR set
5. Reduce inlet dust loading in Flue gas at Inlet of ESP
6. Installation of Harmonic filters to reduce the effect of harmonics
7. Increase Surface collection area / SCA i.e. increase in ESP size
8. Moisture ingression, Sulphur dosing, Silica dosing
9. Reduce back end flue gas temperature i.e. at Inlet of ESP as Emission is directly proportional to high inlet gas temperature >150ºC
10. Reduce Flue gas flow at Inlet of ESP
11. Reduction of Potassium & Chloride salt concentration in fuel by mixing
12. Change in operation mode & type of ESP controller

Low Resistivity of Fly Ash (Ohm-cm) is $<10^7$
Normal Resistivity of Fly Ash (Ohm-cm) is $>10^7$ to $<10^{10}$
Mild High Resistivity of Fly Ash (Ohm-cm) is $>10^{10}$ to 10^{11}
High Resistivity of Fly Ash (Ohm-cm) is $>10^{12}$

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